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IDENTIFYING AND TEACHING CREATIVITY. THE GENERAL COLLEGE STUDIES, UNIVERSITY OF MINNESOTA, VOLUME I, NUMBER 1, 1963-1965.

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STUDIES WERE DESIGNED TO DETERMINE WHETHER CREATIVITY CAN BE MEASURED AND TAUGHT. THE INVESTIGATORS DEFINED CREATIVITY IN EXPERIMENTAL TERMS, BASED ON SCORES OBTAINED BY MEASURING FOUR FACTORS--FLUENCY, FLEXIBILITY, ORIGINALITY, AND ELABORATION. FLUENCY IS THE FACILITY WITH WHICH IDEAS CAN BE GENERATED, FLEXIBILITY IS THE NUMBER OF DIFFERENT PRINCIPLES, STRATEGIES OR APPROACHES USED IN RESPONSE TO A TASK, ORIGINALITY IS THE UNIQUENESS OF THE RESPONSE TO A TEST ITEM, AND ELABORATION IS THE NUMBER OF DETAILS SUPPLIED BEYOND THOSE NECESSARY TO COMMUNICATE A BASIC IDEA. RESULTS OF THREE STUDIES INDICATED THAT (1) STUDENTS IN CLASSES FOR CREATIVE THINKING CAN GAIN IN ORIGINALITY, (2) TESTS CAN BE DEVISED TO MEASURE THE VARIOUS FACTORS OF CREATIVITY, AND (3) IN TESTS OF CREATIVITY, THERE IS LITTLE RELATIONSHIP BETWEEN VERBAL AND NONVERBAL TASKS, WITH HIGHER CORRELATIONS BETWEEN FACTORS WITHIN VERBAL AND NONVERBAL TASKS. FOR OTHER REPORTS IN THIS SERIES, SEE JC 670 962 AND JC 670 970. (HH)

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IDENTIFYING AND TEACHING CREATIVITY

Part One : Experimentally Defining Creativity
Part Two : Measuring Originality Improvement
Part Three : Comparing Tests of Originality
Part Four : Investigating Creativity Factor and Task Relationships

Fred M. Amram

David L. Giese

There are a number of reasons why our faculty ventures to issue The General College Studies now. A fresh interest on college campuses in the techniques and quality of undergraduate instruction appears to be one of the characteristics of education today. This interest coincides with establishment of scores of new two-year colleges, and with the creation of an Educational Research Information Center (ERIC) by the United States Office of Education. By means of The General College Studies, we intend to contribute to the ERIC Clearinghouse for Junior College Information - as well as to others in the academic community - research findings and reports which describe some of our work in curriculum and instruction, testing, counseling, evaluation, and administration, and which will reflect the two-year program we offer at the University of Minnesota. We begin, as the date of this volume indicates, with a backlog of material.

Volume one of The General College Studies is composed of a series of investigations into education and creative potential. These investigations began in the early 1960's when Professor Amram started to experiment with ways of defining and testing creativity. As the reports themselves make clear, some of Professor Amram's initial research derived from the work in creativity in young children by Professor E. Paul Torrance, formerly of the University of Minnesota College of Education. Since the original experiments, the team of Amram and Giese has systematically explored the problem of how to stimulate creativity in college students, and how to measure changes in creative skills and abilities.

In this first number of volume one, part three originally constituted a paper read by Professor Amram at the First Annual Creative Problem Solving Institute held at Macalester College, Saint Paul, in July, 1964. A report based upon part four was read by Professor Giese at the Second Annual Creative Problem Solving Institute at Macalester in July, 1965.

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I : EXPERIMENTALLY DEFINING CREATIVITY

Creativity is not a new phenomenon. As long as man has been able to "imagine" he has exhibited creative potential in his aesthetic and practical life. What is new is that modern science has made it possible to understand human behavior in greater detail and has increased the possibility of discovering what behavioral factors are common to the unusually inventive individual. It may be possible now to estimate the impact of different stimuli on the inventive potential of different populations. To the educator this means that it is possible to cause people to behave more creatively, and if creative behavior is judged to be a desirable characteristic of modern man, the schools may want to adapt their curriculums accordingly.

Recent years have witnessed a request from business and industry for more creative young men and women. Although such demands are still fuzzy, some educational changes may be desirable. Furthermore, increased unemployment and the inevitable decrease in working hours seem to indicate a need for a re-evaluation of the role of creativity in new kinds of employment and in leisure time activities.

We propose to investigate several questions concerning the identification and teaching of creative skills. Three questions need to be examined before such research can be undertaken. (1) What is creativity? (2) How can creativity be measured? (3) Can creativity be taught?

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What is creativity and how can it be measured?

While we find it difficult (if not impossible) to compose a definition of creativity which will satisfy the philosopher, we do know that in certain situations individuals who have patented many inventions and those who have unique abilities in the creative arts behave differently from the rest of the population. This behavior may differ in quality or in quantity. Previous research by Torrance,[1] Guilford,[2] Taylor[3] and others indicates at least partial success in identifying some variables which distinguish the creative person from the less creative individual. Moreover, it appears that creativity is not just a unitary or single aspect of behavior, but a compound of several factors each of which describes different kinds of creativity. For example, Guilford[4] has identified a variety of abilities. About one of these abilities, problem sensitivity, he points out that individuals who are alert to the existence of problems have increased probability of coming up with solutions. Further, he identifies word fluency, ideational fluency, associational fluency, expressional fluency, spontaneous flexibility, adaptive flexibility, and originality.

In the present investigation we propose to follow Torrance's[5] cue by defining creativity in experimental terms, that is, from the scores obtained by measuring four factors: fluency, flexibility, originality, and elaboration. Fluency, the facility with which ideas can be generated, is defined in tests simply as the total number of relevant responses (such as the total number of ideas, solutions). Presumably, the person who demonstrates this aspect

of creativity is able to think up many ideas. As long as the responses are relevant, quantity is more important than quality in the measurement of this factor.

The flexibility score is obtained by counting the number of categories into which the testee's responses can be classified. Flexibility, perhaps the opposite of rigidity, refers to the number of different principles, strategies, or approaches used in responding to a task. The suggestion is that a flexible individual would not only be able to list many solutions to a problem but would also be able to list different kinds of solutions. For example, if one were asked to list uses for a tin can he might suggest that it can be used as a container to hold soup, peas, paper clips, nails, and other things. In each case the solution falls into the container category. However, the flexible person might use different approaches (with or without modifying the tin can). He might suggest using the tin can as a construction material, an art material, an animal shelter, a weight, a weapon, a musical instrument, or a trap. Each of these involves a different principle for solving the problem, and in each of these categories one might suggest a number of responses. Flexibility, then, is measured by counting not the number of responses, as in fluency, but the different categories of responses to a test stimulus.

Originality refers to the uniqueness of the response to a test item. To devise originality scoring, a test item is administered to a large sample of testees. The responses are counted and put into groups of frequency of response. A very common or

frequent response is assigned 0 points. A response given by one or very few testees is awarded 4 points (or some arbitrary number depending on how fine a measuring device the tester desires to develop). Other responses are grouped into frequency categories and assigned a score of 1, 2, or 3 with the higher score being awarded to the less frequent response. However, all responses must be appropriate to the problem situation. A non-sequitur response will not be labeled as original just because no other testee has responded in the same way. The response must be meaningful before it is measured.

Torrance[6] points out that two assumptions underlie the scoring of elaboration. The first is that the minimum and primary response to the stimulus is a single response. The second is that the intergration and exposition of detail is a function of creative ability. The problem is to determine the extent to which the idea is spelled out or elaborated by counting the details over and above what is necessary to communicate the basic idea. In responding to the "unusual uses for the tin can" problem, the subject might suggest using the can to hold straws. The basic idea is communicated, but no detail is offered; therefore, the elaboration score is 0. If the subject suggests smoothing the edges and using the can to hold straws, his elaboration score would be 1. If he suggested smoothing the edges and painting the can to use as a container for straws, the subject would be awarded 2 points for the two details added to the basic idea.

In the present investigation, we are concerned with measuring the factors of fluency, flexibility, originality, and elaboration.

Furthermore, we utilize some test problems which require verbal responses and others which require non-verbal responses (figure completion type). We are interested in establishing what differences, if any, exist between different types of testees on both verbal and non-verbal creative abilities. If such differences exist, we would like to identify the types of subjects who manifest such differences and the circumstances under which such differences are highlighted or reinforced.

The above comments certainly imply that test situations can be so structured that they measure certain skills or abilities which may be related to creativity. Do the tests measure what the testers claim they are measuring? How precise and consistent are the measuring devices? Previous researchers report some success with several measuring devices while cautiously warning of potential errors with others. Our results, of course, are dependent on the reliability and validity of the tests used.

Can creativity be taught?

By administering pre-and post-tests of creativity to a variety of classes, we can measure changes in response to the tests, and by comparing the results, we can make some comments about the comparative effects of different courses on the behaviors we are measuring. Furthermore, by testing students enrolled in courses designed to teach creative problem-solving and by comparing these results and the results obtained from tests administered to control groups, we can identify, to some extent, the effects of teaching creativity. Previous research by Parnes,[7] Sommers[8]

and others indicates that students enrolled in courses designed to stimulate creative abilities do in fact improve in at least some of the creative abilities which have been measured. Our intent is to find what changes occur in which abilities, and to what degree.

Summary

In summary we have attempted to utilize operational and experimental terms to identify the behavior we are measuring. In this way results may lead to a more objective and scientific understanding of creativity. We hope that in this way we also will obtain a clear and objective measurement of what results can be expected from a course designed to teach students to tackle problem-solving situations with greater imagination. Our hypotheses must necessarily be relatively narrow and restricted so that they will be testable. Hopefully, data gathering, such as that exhibited in this investigation, will make it possible for future researchers to state more general hypotheses and in turn shed more light on creative processes.

We are tremendously indebted to Dr. E. Paul Torrance, formerly Director of the University of Minnesota Educational Testing Bureau and now chairman of the department of educational psychology at the University of Georgia, Athens. We made free use of his tests, his advice, and the body of research and theory he has developed.

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   E. Paul Torrance, Creativity - What Research Says to the Teachers, Washington 6, D.C.: National Education Association of the United States, April 1963.

2. J. P. Guilford, "Creativity: Its Measurement and Development." In Sidney J. Parnes and Harold F. Harding, eds., A Source Book for Creative Thinking, New York: Charles Scribner's Sons, 1962.

3. Calvin W. Taylor, "A Tentative Description of the Creative Individual." In Sidney J. Parnes and Harold F. Harding, eds., A Source Book for Creative Thinking, New York: Charles Scribner's Sons, 1962.

4. Guilford, op. cit.

5. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.

6. Ibid., p. 19

7. Sidney J. Parnes, "Effects of Extended Effort in Creative Problem-Solving," Journal of Educational Psychology, LII (1961), pp. 117-122.

   Sidney J. Parnes and Arnold Meadow, "Evaluation of Persistence of Effects Produced by a Creative Problem-Solving Course," Psychological Reports, VII (1960), pp. 357-361.

8. Wesley Sommers, The Influence of Selected Teaching Methods on the Development of Creative Thinking, unpublished Ph.D. dissertation, University of Minnesota, 1961.

II : MEASURING ORIGINALITY IMPROVEMENT

Our first investigation is an experiment simple in its hypothesis as well as in its design. The lack of control groups and the small sample make it almost unscientific. Our intent was to compare student scores on a simple test of originality before and after the subjects took a course designed to teach creative problem-solving. We also compared these scores with results reported by Cunnington and Torrance[1] with the same test and different types of subjects.

Subjects

Our subjects were General College students who completed a class identified as 33B "Creative Speech Activities." The General College, an undergraduate college of the University of Minnesota, offers a program of general education culminating in the two-year Associate in Arts degree. Although 2 - 3% of the students come to the General College because they choose to participate in a program of general education before they specialize in other colleges, and another 5 - 10% transfer to the General College because they have been unsuccessful in other colleges, most of the General College population is composed of high school graduates who were not accepted by other colleges. For such students, the University offers the opportunity to gain some college education and the possibility of transferring to other schools if their achievement warrants. General College students have an average I.Q. between 105--110 and have an average high school rank of 28%, compared to College of Liberal Arts students

who have an average I.Q. of 115 - 120 and an average HSR of 70% for men and 80 - 85% for women. The population with which we are dealing is generally a low-achievement group.

The students had completed at least one beginning speech course prior to their registration in GC 33B. They were recommended by previous speech teachers. While recommendation for this course does not necessarily mean that the subjects were honor students, they certainly were in the top 50% of their speech class.

The Setting

GC 33B, Creative Speech Activities, during the Winter Quarter of 1963, was taught as a course in creative problem-solving. The official description of the course was as follows:

GC 33B, Creative Speech Activities, for Winter, 1963 (Prerequisite for this course is GC 32A, recommendation of an instructor in oral communication, and permission of the 33B instructor, Mr. Amram.)

> GC 33B (Creative Speech Activities) for winter quarter 1963 will be organized around a study of creativity and creative problem-solving. Emphasis will be directed toward making students aware of the need for creative behavior in business, industry, community affairs, and in the arts. Students will participate in exercises to help them become more sensitive to problems, better able to analyze them, and to demonstrate some of the techniques which aid in the discovery of unique solutions (attribute listing, morphological analysis, brainstorming, etc.). Students also will be required to devise ways to apply solutions and to communicate their ideas to others persuasively. With individual and group exercises students will demonstrate their creative abilities to themselves and to the class.
>
> Class discussion about the social and emotional blocks to creative behavior will be designed to help students discover and over come their own blocks. The class will work in an extremely permissive atmosphere. Each student will be encouraged to follow his own interests and to work on individual projects.

Most of the activities of the course were centered around a student workbook written by Sidney J. Parnes.[2] The students also read from Alex Osborn's Applied Imagination.[3] During most of the quarter the students were engaged in problem solving situations with assigned problems and problems selected by the individual students. The students also had some opportunity to apply the skills emphasized in the course to creative dramatics, to the visual arts, and to miscellaneous individual interests.

The Test

The test consisted of a tape recording of four "strange" or "unusual" sounds, each sound more complex and "strange" than the previous one. The students were given answer sheets (see following page) with empty boxes. For each sound they heard, the students were to write "word pictures" in the appropriate spaces. After they heard the four sounds, they were told by the narrator on the tape to fold their papers over, exposing row B. They were to write new word pictures as they heard the same sounds again. The narrator encouraged the listeners to use imagination while listening to the sounds. After hearing the sounds again, the students were asked to try a third time, and again they were encouraged to use imagination. The entire tape runs seventeen minutes.

WORD-PICTURES FROM SOUNDS

Name:_____ Date:_____

Form: I_____ II_____ Age:_____ Educ. Status:_____

	Sound 1	Sound 2	Sound 3	Sound 4
A				
B				
C				

The tape and the scoring formula were devised by Cunnington and Torrance.[4] The responses were scored only for originality. The scoring, which has been standardized by the authors of the Sounds and Images test, awards four points for unique answers and zero points for the most common answers. The scores for the twelve responses are added for a total test score.

The Sounds and Images test was administered on the second class day and the last class day. Only the scores of those students who took both the pre- and the post-test were used in our calculations.

The Results

The table on the following page summarizes Cunnington and Torrance's data,[5] with our results reported on the bottom two lines of the table.

Testing the hypothesis that the class did not improve during the quarter, with the alternative that they did, we used a t-test with a one-aided alternative and found that the 33B students made more "original" responses on the post-test than they made on the pre-test. The gain was significant at least at the .C5 level.

To test the hypothesis that pre- and post-test variances were essentially equal, we used the F-test for correlated measures and found no significant change. In other words, the spread of the student scores on the post-test was not different from that on the pre-test.

Tentative Norms for Originality Score Based on Sound Effects Tape No. 2

Group	Number	Means	Standard Deviation
Fourth Grade	32	24.9	7.44
High School Students (art inst.) (post-test)	16	41.0	----
Graduate Students in Educational Psychology	61	28.9	7.54
Teachers	306	25.1	10.00
Student Teachers	34	33.2	6.08
GC 33B W'63 (Pre)	16	30.8	7.32
GC 33B W'63 (Post)	16	34.8	6.06

Table of References

1. Bert F. Cunnington and E. Paul Torrance, Sounds and Images, University of Minnesota: Bureau of Educational Research, 1962.

2. Sidney J. Parnes, Student Workbook for Creative Problem-Solving Courses and Institutes, Buffalo: University of Buffalo Bookstore, 1961.

3. Alex F. Osborn, Applied Imagination, New York: Charles Scribner's Sons, 1961.

4. Cunnington and Torrance, op. cit.

5. Ibid., P. 19.

III : COMPARING TESTS OF ORIGINALITY

In addition to the test (Sounds and Images)[1] described in the foregoing, the students enrolled in GC 33B, Creative Speech Activities during the winter quarter, 1963, took the Minnesota Test of Creative Thinking : Abbreviated Form VII which yields originality scores on non-verbal as well as verbal tasks.

The two non-verbal tasks consisted of a series of incomplete figures and a series of parallel lines, both of which the students were to use as bases for pictures. In the verbal tasks, the students were asked to make suggestions for improving the toy dog drawn on the test form, and to devise unusual uses for the common tin can.

Only the scores of the 16 students who completed both the pre- and post-tests of Sounds and Images and Abbreviated Form VII were used in this part of our investigations.

Method

To compare the various originality scores, we used the Product Moment Correlation Coefficient. Correlational analysis measures whether or not the subjects maintain their relative positions on the various scales. For example, we wanted to determine whether or not students who have relatively high scores on the Sounds and Images test or originality also have relatively high scores on the other measures of originality. The correlation coefficient is standardized to be a "plus one" if the scores are perfectly, positively related; a "minus one" if the scores are perfectly, negatively related; and a number near zero if there is little relationship.

The correlation coefficients for the following pairs of originality scores were computed from the pre-test results: Sounds and Images with each of the four Tasks, the non-verbal total, the verbal total, and the grand total of the Abbreviated Form VII test; Task 1 with Tasks 2, 3, and 4, the non-verbal total, the verbal total, and the grand total; Task 2 with Tasks 3 and 4, non-verbal total, verbal total, and the grand total; the non-verbal total with Tasks 3 and 4, the verbal total, and the grand total; Task 3 with Task 4, the verbal total, and the grand total; Task 4 with the verbal total and the grand total; the verbal total with the grand total. Table 3.1 indicates the the correlations not listed in the previous sentence are only a reflection of the correlations listed.

On the post-test we compared only the scores from the Sounds and Images test to each of the four tasks and three totals from the Abreviated Form VII test. In addition, the correlation between the pre-test and the post-test on each of the eight measures was computed.

Table 3.1

The Correlation Coefficients Between Each of the Originality Pre-Test Scores With Each of the Other Originality Pre-Test Scores

	Non-Verbal Scores			Verbal Scores			Grand
	Task 1	Task 2	Total	Task 3	Task 4	Total	Total
Sounds and Images	.36	-.15	-.02	.19	.21	.24	.22
Task 1		.45	.67**	-.04	-.18	-.12	.25
Task 2			.96**	-.27	-.03	-.21	.32
Non-Verbal Total				-.23	-.08	-.21	.34
Task 3					.39	.91**	.75**
Task 4						.74**	.67**
Verbal Total							.85**

* significantly different from zero at the .05 level
** significantly different from zero at the .01 level

Table 3.2

The Correlation Coefficients Between the Sounds and Images Scores and the Originality Scores from Abbreviated Form VII Creativity Test Given as Pre-Tests and Post-Tests

	Non-Verbal Scores			Verbal Scores			Grand
	Task 1	Task 2	Total	Task 3	Task 4	Total	Total
Pre-Test	.36	-.15	-.02	.19	.21	.24	.22
Post-Test	-.06	-.08	-.09	.46	.27	.43	.37

None are significantly different from zero

Table 3.3

The Correlation Coefficients Between Pre-Test and Post-Test Scores for Each of the Originality Test

Sounds and Images	.33	Task 3	.33
Task 1	.33	Task 4	.19
Task 2	.50*	Total Verbal	.43
Total Non-Verbal	.50*	Grand Total	.26

* significantly different from zero at the .05 level

Results

The correlation coefficients between the possible pairs of variables on the pre-test measures are given in Table 3.1. The correlations between the Sounds and Images scores and the Abbreviated Form VII scores on the post-tests are listed in Table 3.2. Finally, the correlations between the pre-test and post-test scores are listed in Table 3.3. A single asterisk next to a coefficient indicates that it is significantly different from zero at the .01 level. For us to be able to say that there is a relationship not due to chance between two variables, the coefficient should be significant at least at the .05 level. Examination of the three tables points to the following results:

1) There seems to be no relationships on the pre-test variables except the forced relationships of the totals with their constituent parts.

2) The negative coefficients are relatively unimportant because the correlations are not statistically significant.

3) On Table 3.1, Task 2 clearly outweighs Task 1 in determining the non-verbal total.

4) The grand total is determined primarily by Tasks 3 and 4, apparently because the standard deviation of the verbal tasks is much greater than the standard deviation of the non-verbal tasks.

5) No significant correlations show up between the Sounds and Images post-test and the Abbreviated Form VII post-test.

6) There are no significant correlations between the pre-test and post-test scores except on Task 2 and the non-verbal total, which are barely significant. Again, the significant correlation on the total non-verbal scores can be explained by the fact that they are made up primarily of Task 2.

Conclusions

The analysis of the scores of the sixteen students whose scores were included in this investigation indicates that no significant relationships exist among the various measures of originality. It may be that the tests are measuring different skills or abilities, or different types of originality.

It is interesting to note that except in Task 2 no significant correlations were found between the pre-test scores and the post-test scores. A possible explanation for this phenomenon is that on the post-test, in the Creative Problem Solving class, the students are operating at or near the ceilings imposed by the test or the time limits. The instructor observed that although the students wrote for the entire time allotted on the post-test they seemed to run out of ideas before the time limits had elapsed on the pre-test.

Table of References

1. Bert F. Cunnington and E. Paul Torrance, Sounds and Images, University of Minnesota: Bureau of Educational Research, 1962.

2. E. Paul Torrance, Administration and Scoring Manual for Abbreviated Form VII Minnesota Tests of Creative Thinking, University of Minnesota: Bureau of Educational Research, 1962.

IV : INVESTIGATING CREATIVITY FACTOR AND TASK INTERRELATIONSHIPS

Our primary purpose in the study described below has been to investigate these facets of the Minnesota Tests of Creative Thinking : Abbreviated Form VII:

1. The interrelationships among the four factors measured by the test (fluency, flexibility, originality, and elaboration) and among the four tasks or parts of the test; the effect of controlling the fluency factor upon the interrelationships among tasks and factors.

2. The reliability of the testing tool.

3. The possibility of devising a more economical scoring method.

4. The relationships among gains in creativity scores earned by students who have taken tests of creative skills before and after involvement in various General College courses.

Four groups of subjects were involved in this study:

1. Seventeen students enrolled in GC 33B, described in Part II, above.

2. Twenty-nine students enrolled in GC 5B, "Functions and Problems of Logic." This course is officially described as follows: "The student studies and attempts to apply the rules of sound argument and valid inference. He is shown the relationship of formal patterns of reasoning to such uses of ordinary language as argument, propaganda, and persuasion. He is also shown the manner in which formal logic is employed as a tool by the scientist and the mathematician."

3. Sixty-four male students enrolled in the College of Liberal Arts of the University of Minnesota. These students were enrolled in two beginning courses in speech (Speech 5). As the comparison given in part II above indicates, the population of the Arts college is a scholastically superior group, while that of the General College is more typical of all high school seniors.

4. Twenty-seven General College freshman male students who were enrolled in three sections of a beginning speech class, GC 32A. The objectives of this course are to learn the basic principles of speech, and to apply them by means of such assignments as an introduction, a demonstration, an argument, and a group discussion. The purpose of these activities is to help the student develop self-confidence, to express his idea clearly and effectively, and to listen critically.

Methods:

The basic statistical technique used in this study is the Pearson product moment correlation coefficient. The correlation coefficient measures the relationship between two sets of scores. A value at or near +1 indicates a high positive relation and a value at or near -1 indicates a high negative relation. A value near zero indicates little or no relationship between the scores being compared.

The procedures were as follows:

1) Correlation coefficients for all pairs of factors on each task were computed (e.g. fluency with flexibility on Task 1, fluency with elaboration on Task 1, etc.). Also compared were the different tasks for each factor (e.g. fluency on Task 1 with fluency on Task 2, fluency on Task 1 with fluency on Task 3, etc.). These comparisons for factors and tasks were made using pre-test scores for the four groups (33B, 5B, CLA males, GC freshman males).

2) The correlations listed in item 1 (above) were computed for post-test scores of two of the groups (33B, 5B).

3) Correlation coefficients between pre-test and post-test scores for each of the four factors on each task for two groups (33B, 5B) were computed (e.g. fluency pre-test score on Task 1 with fluency post-test score on Task 1, Flexibility pre-test score on Task 1 with flexibility post-test score on Task 1).

4) Correlations among gains for factor-task combinations of two groups (33B, 5B) were calculated (e.g. fluency Task 1 gain with flexibility Task 1 gain, fluency Task 1 gain with elaboration Task 1 gain).

5) A set of flexibility scores and a set of originality scores were predicted from fluency raw scores. These predicted scores were compared with the actual scores achieved by subjects who took the test. The predicting tool was a regression equation. The regression equation is a device to predict one score from another score. The method followed was to use the simplest regression equation, $y = a + bx$, where y is the unknown factor to be predicted, a and b are constants which are determined from the available data, and x is the fluency raw score.

Much of the data correlated consisted of raw scores earned by the subjects on the four tasks and Four Factors (fluency, flexibility, originality, elaboration) which constitute the test of creative thinking. However, it was discovered early in the study that a high correlation existed between fluency and flexibility and between fluency and originality on many of the tasks. It appeared necessary to free the flexibility and originality scores

from the fluency effect so that they could be studied as independent scores and it was decided to express the flexibility and originality scores as percentages of fluency. In other words an adjusted flexibility score was devised by dividing the raw flexibility score by the raw fluency score and multiplying by 100.

Another way to express the need for adjusted scores is as follows: the high correlations between fluency and flexibility and between fluency and originality implied that one could predict flexibility and originality from fluency raw scores. This ability to predict would save the time and effort of scoring test papers for flexibility and fluency. However, it seemed desirable to be able to identify factors which are not predictable from fluency scores. This adjusted score might identify such factors. To illustrate--the adjusted score could help identify an "originality type" who is not fluent (apparently not a common situation), i.e. a person who doesn't list many ideas, but whose ideas are original.

The adjustment is arbitrary and may not be the ideal way to identify the factor we are seeking. It is at best a first effort. It is computed as follows (using flexibility as an example): A subject with a fluency raw score of 25 (he gave 25 relevant responses to a problem) and a flexibility raw score of 10 (10 different stategies were identifiable among the 25 responses) is assigned an adjusted flexibility score of 10/25 x 100 = 40. Two additional hypothetical examples are given below:

flu raw score	flex raw score	flex adjusted score
25	20	20/25 x 100 = 80
10	10	10/10 x 100 = 100

Raw scores and adjusted scores were used to make the comparisons identified in procedures 1, 2, and 3 above. Raw scores only were used to make the comparisons identified in procedures 4 and 5 above.

Results

The results reported here are gleaned from tables which appear at the end of this report. Asterisks on the tables indicate correlation coefficients significantly different from zero (+ or -).

Table 4.1 identifies high correlations among fluency, flexibility, and originality on the non-verbal, pre-test raw scores. Some significant correlations among these same three factors are found on the verbal pre-test raw scores, although fewer than on the non-verbal tasks. Significant factor correlations with elaboration are few and inconsistent.

Post-test scores show high correlations between fluency and flexibility and between fluency and originality. The correlation between flexibility and originality is high for the 5B group but not high for the 33B group (the class which was taught creative problem-solving procedures). The correlation between elaboration and the other factors is generally low. In the few cases where the correlations on the post-test between elaboration and other factors are significantly different from zero, the figures indicate negative correlations for 33B and positive correlations for 5B.

Table 4.2 indicates that correlations between adjusted scores for factors within tasks decrease.

Table 4.3 shows the correlations between raw scores for tasks within factors. The pre-test results show high correlations between tasks one and two. There are some significant but inconsistent correlations between tasks three and four. Little correlation exists between the verbal tasks (three and four) and the non-verbal tasks (one and two).

On the post-test, the correlations decrease, especially for the 33B class.

Table 4.4 shows few significant correlations between adjusted scores for tasks within factors, except between tasks one and two on elaboration.

Table 4.5 shows the correlations between pre-test and post-test scores. The correlations between pre-test and post-test scores are generally quite high on tasks two and four and generally low on tasks one and three for both raw and adjusted scores.

The top half of table 4.6 shows correlations between gains from pre-test to post-test for factors within tasks. Generally high correlations on the non-verbal tasks (one and two) exist between fluency and flexibility; slightly smaller correlations exist between fluency and originality and between flexibility and originality. Correlations significantly different from zero exist between fluency and originality on the verbal tasks.

The bottom half of table 4.6 shows that correlations between gains from pre-test to post-test are generally low for tasks within factors.

Table 4.7 shows task two raw scores for all students in the 5B class. The table also shows the flexibility, originality and elaboration scores which were predicted from the observed fluency scores. It is interesting to note that raw flexibility and originality scores tend to fall in a low-score sequence which conforms to the low to high fluency sequence.

Predicted scores for flexibility, based on a regression equation, are quite close to the observed flexibility scores. Similarly, predicted scores for originality are fairly close to observed originality scores. Predicted and observed scores for elaboration are not close and reflect the low correlation between fluency and elaboration.

Conclusions

1. Although one does not expect a close relationship between verbal and non-verbal scores, one does expect a relationship between the two verbal tasks and between the two non-verbal tasks. As expected, the correlations between the verbal and non-verbal tasks were low. Contrary to expectations the correlations between tasks three and four were also low. The correlations between tasks one and two were higher but still not very high. Interestingly the correlations among the tasks were not even as high as the correlations among the factors.

The correlations among the factors on the pre-test scores indicate that a close relationship exists among fluency, flexibility, and originality, especially in the non-verbal tasks. Parnes[2] and Osborn[3] have reported similar findings. The low correlations

between elaboration and the other factors indicate that the test of elaboration is measuring a skill independent of the other factors.

Post-test findings are similar to pre-test findings. Interestingly, the correlations among the factors have decreased for the 33B class post-test. Apparently the 33B students scores are not similarly influenced on the various tasks and factors. Because of high correlations among fluency, flexibility, and originality raw scores, the analysis was repeated with adjusted scores. The adjustment (explained in the section on "methods") was apparently effective, as evidenced by the decreased size of the correlations. The many negative correlations among the factors--sometimes significant--on the adjusted scores indicates that the adjustment may have been excessive. If there is need for more than a fluency score, flexibility and originality scores can be separated from fluency with an adjustment, although the adjustment reported here may not be the best one.

The low correlations among gains for tasks within factors again indicate that the tasks may be measuring different facets of creative abilities. Some significant correlations among factors within tasks again point to the conclusion that the fluency, flexibility, and originality factors are interrelated, especially on the non-verbal tasks.

2. If one assumes that the two verbal tasks (or the two non-verbal tasks) are measuring the same characteristics, then he must assume a fairly high correlation between the tasks. Such high correlations were not found between the two verbal tasks, nor were they found between the two non-verbal tasks. One

might use the data to argue that these four tasks are really measuring four different facets of creativity. Perhaps, however, the low correlations are in part due to a difficulty the student may experience because of the limited time (ten minutes) allowed for each task. If the four tasks are indeed measuring different facets of creativity skills, then each task needs to be tested to determine whether or not it measures what it is designed to measure. This observation implies the need for a clear statement identifying what each task is designed to measure.

Substantial changes in sequence of scores between pre- and post-tests on tasks one and three indicate a lack of test-retest reliability. Tasks two and four do show fair pre- post-test correlations--hence, fair test-retest reliability. The question of whether or not the test ought to be producing similar measurements before and after a two and one-half month time span is crucial at this point, particularly for the 5B class where no formal effort was made to change creativity-related behavior. If the test is to be used as a predictor of creative abilities it ought to measure consistently over a limited period of time (i.e. at least one academic quarter--2 1/2 months).

3. The high correlations between fluency and flexibility and between fluency and originality indicate that it is possible to avoid scoring flexibility and originality, thereby decreasing the scoring costs greatly. The flexibility and originality scores can be predicted (if desired) from the fluency scores, especially on the non-verbal tasks (see table 4.7).

Table 4.1

Correlations between raw scores for factors within tasks for four groups on a test of creative skills administered twice for 33B and 5B and administered once for CLA and GC.

	TASK ONE			TASK TWO			TASK THREE			TASK FOUR		
FIRST ADMINISTRATION	flex	orig	elab	flex	orig	elab	flex	orig	elab	flex	orig	elab
FLUENCY												
33B	.88*	.55*	.09	.99*	.89*	-.07	.08	.78*	.46	.38	.28	.11
5B	.93*	.64*	.28	.92*	.79*	.34	.29	.89*	.60*	.42*	.79*	.40*
CLA	.82*	.40*	.08	.71*	.55*	-.01	.70*	.85*	.07	.86*	.86*	.11
GC	.80*	.43*	.08	.83*	.69*	.13	.74*	.79*	.10	.80*	.81*	-.24
FLEXIBILITY												
33B		.56*	.07		.86*	-.09		-.02	-.07		.43	-.01
5B		.65*	.36		.70*	.19		.12	.11		.31	.20
CLA		.52*	.26*		.66*	.06		.56*	.07		.85*	.26*
GC		.67*	.37		.76*	.15		.53*	.05		.75*	-.20
ORIGINALITY												
33B			.16			-.24			.28			.12
5B			.48*			.56*			.54*			.08
CLA			.29*			.07			.27*			.19
GC			.30			.33			.10			.17
SECOND ADMINISTRATION												
FLUENCY												
33B	.50*	.57*	-.38	.81*	.78*	-.49*	.06	.90*	.26	.57*	.90*	-.19
5B	.77*	.40*	.02	.88*	.77*	.41*	.53*	.92*	.14	.81*	.76*	.18
FLEXIBILITY												
33B		.06	-.33		.71*	-.48*		-.05	.33		.32	.03
5B		.38*	.12		.75*	.58*		.50*	.03		.81*	.23
ORIGINALITY												
33B			-.34			-.16			.18			-.37
5B			.30			.70*			.04			.11

* Asterisk identifies correlations significant at the .05 level

Table 4.2

Correlations between adjusted scores for factors within tasks for four groups on a test of creative skills administered twice for 33B and 5B and administered once for CLA and GC.

	TASK ONE			TASK TWO			TASK THREE			TASK FOUR		
PRE-TEST	flex	orig	elab	flex	orig	elab	flex	orig	elab	flex	orig	elab
FLUENCY												
33B	-.08	.41	-.18	.56*	-.27	-.53*	-.44	.47	-.18	-.81*	-.54*	-.29
5B	.02	-.11	-.32	-.43*	-.12	-.10	-.33	-.03	.08	-.93*	-.18	.06
CLA	-.14	-.17	-.53*	-.65*	-.11	-.33*	-.52*	.26*	-.24	-.43*	.18	-.24
GC	.04	-.17	-.25	-.16	-.09	-.31	-.67*	-.16	-.54*	-.33	.42*	-.36
FLEXIBILITY												
33B		.15	.11		-.14	-.60*		-.37	-.04		.46	.38
5B		.14	.08		.14	-.08		-.32	-.06		.19	-.18
CLA		.43*	.29*		.24	.27*		-.05	.20		.39*	.40*
GC		.56*	.47*		.27	.32		.35	.60*		.21	.49*
ORIGINALITY												
33B			.33			-.39			-.13			.17
5B			.32			-.28			-.01			.49*
CLA			.39*			.13			.22			.14
GC			.29			.35			.46*			.16
POST-TEST												
FLUENCY												
33B	-.12	.44	-.54*	-.32	.09	-.74*	-.78*	.05	-.08	-.76*	.48*	-.32
5B	.22	-.15	-.55*	-.56*	.25	-.34	-.67*	.09	-.19	-.62*	.08	-.17
FLEXIBILITY												
33B		.37	.06		.01	.06		-.00	.23		-.53*	.48*
5B		.02	.04		.04	.36		-.11	-.00		.12	.23
ORIGINALITY												
33B			-.39			.28			-.22			-.30
5B			.30			.30			-.27			-.07

* Asterisk identifies correlations significant at the .05 level

Table 4.3

Correlations between raw scores for tasks within factors for four groups on a test of creative skills administered twice for 33B and 5B and administered once for CLA and GC.

	FLUENCY			FLEXIBILITY			ORIGINALITY			ELABORATION		
FIRST ADMINISTRATION	two	three	four	two	three	four	two	three	four	two	three	four
TASK ONE												
33B	.56*	.10	.28	.55*	.16	-.27	.53*	-.16	-.06	.32	.08	.20
5B	.56*	.54*	.13	.45*	.24	-.11	.46*	.20	.25	.80*	.17	.02
CLA	.54*	.21	.11	.45*	.13	.06	.25*	.25	.06	.35*	.36	.61
GC	.72*	.58*	.62*	.52*	.50*	.57*	.45*	-.10	.56*	.82*	.24	.06
TASK TWO												
33B		-.37	-.09		.11	-.18		-.39	.11		-.24	.20
5B		.66*	.51*		-.01	.16		.61*	.47*		.24	.47*
CLA		.16	.19		.25*	.24		.12	.08		.14	.05
GC		.76*	.50*		.75*	.68*		.53*	.52*		.23	-.25
TASK THREE												
33B			.46			-.29			.24			-.01
5B			.41*			-.46*			.36			.56*
CLA			.60*			.00			.56*			.42*
GC			.65*			.59*			.73*			-.23
SECOND ADMINISTRATION												
TASK ONE												
33B	.37	.16	.21	.13	.14	.00	.30	.23	.08	.56*	.10	-.38
5B	.43*	.38*	.30	.29	.24	.05	.32	.38*	.31	.76*	-.01	.12
TASK TWO												
33B		-.27	-.08		-.00	.02		-.07	.06		.02	.06
5B		.37*	.38*		.11	.13		.37*	.13		.01	.30
TASK THREE												
33B			.45			-.27			.33			.23
5B			.51*			.34			.41*			.12

* Asterisk identifies correlations significant at the .05 level

Table 4.4

Correlations between adjusted scores for tasks within factors for four groups on a test of creative skills administered twice for 33B and 5B and administered once for CLA and GC.

	Flexibility			Originality			Elaboration		
PRE-TEST	two	three	four	two	three	four	two	three	four
TASK ONE									
33B	.37	.32	.07	-.07	-.13	-.06	.53*	.33	.20
5B	.00	.03	-.24	.43*	.31	.14	.60*	.16	-.20
CLA	.07	.17	.21	.13	.25*	.16	.29*	.36*	.45*
GC	.21	.07	-.12	-.02	-.18	.13	.55*	-.16	.27
TASK TWO									
33B		.52*	.26		.34	-.11		-.01	-.14
5B		.12	.30		.18	.22		.21	.16
CLA		.06	.24		.00	.16		.05	.01
GC		-.40*	-.23		-.44*	.17		-.09	-.03
TASK THREE									
33B		.06			-.36			.33	
5B		.17			-.01			.47*	
CLA		.40*			.40*			.65*	
GC		.12			.17			-.02	
POST-TEST									
TASK ONE									
33B	-.37	-.20	-.20	.43	.46	-.09	.67*	-.07	-.45
5B	.04	-.08	.01	.31	.13	.17	.58*	.07	-.02
TASK TWO									
33B		.10	.35		.29	.19		-.07	-.23
5B		.02	.25		-.28	-.04		-.06	-.01
TASK THREE									
33B		.04			-.12			.13	
5B		.14			.27			.21	

* Asterisk identifies correlations significant at the .05 level

Table 4.5

Correlations between pre-test and post-test scores for two groups on a test of creative skills administered at the beginning and the end of a quarter.

RAW SCORES	TASK ONE	TASK TWO	TASK THREE	TASK FOUR
Fluency				
33B	.12	.72*	.35	.51*
5B	.24	.68*	.56*	.80*
Flexibility				
33B	.07	.66*	.03	.67*
5B	.37*	.47*	.11	.49*
Originality				
33B	.45	.50*	.37	.13
5B	.26	.47*	.51*	.66*
Elaboration				
33B	.18	.08	.02	.62*
5B	.36	.52*	.12	.19
ADJUSTED SCORES				
Fluency				
33B	-.12	.72*	.35	.41
5B	.24	.68*	.56*	.80*
Flexibility				
33B	-.20	.27	.35	.30
5B	.49*	.44*	.39*	.49*
Originality				
33B	.30	.08	.16	-.08
5B	.34	.44*	-.01	.53*
Elaboration				
33B	.23	.49*	-.01	.50*
5B	.39*	.39*	.23	.01

* Asterisk identifies correlations significant at the .05 level

Table 4.6

Correlations between gains from pre-test to post-test for factors within tasks and for tasks within factors for two groups on a test of creative skills.

FACTOR WITHIN TASK CORRELATIONS

		TASK ONE			TASK TWO			TASK THREE			TASK FOUR		
		flex	orig	elab	flex	orig	elab	flex	orig	elab	flex	orig	elab
Fluency	33B	.77*	.10	.02	.53*	.62*	.17	.30	.81*	.31	-.05	.83*	.22
	5B	.86*	.50*	.19	.74*	.73*	.01	.55*	.79*	.13	.11	.08	-.13
Flexibility	33B		.03	.01		.50*	.30		.12	.01		-.05	.10
	5B		.59*	.25		.58*	-.04		.31	.24		.33	-.13
Originality	33B			-.55*			.22			.27			.20
	5B			.31			-.27			.06			.07

TASK WITHIN FACTOR CORRELATIONS

		FLUENCY			FLEXIBILITY			ORIGINALITY			ELABORATION		
		two	three	four	two	three	four	two	three	four	two	three	four
Task One	33B	.26	.13	.01	.39	.59*	-.40	.07	.03	.01	.04	.06	.18
	5B	.20	.28	.08	.06	.20	.03	-.07	.08	.08	.45*	.42	-.18
Task Two	33B		.01	.14		.23	.04		.34	.33		.25	.24
	5B		.02	.04		-.04	-.19		-.03	.17		-.09	-.40
Task Three	33B			.31			-.37			.07			.27
	5B			.00			.20			-.08			.44*

* Asterisk identifies correlations significant at the .05 level

Table 4.7

Observed and predicted scores on task two for GC 5B students.

Subject Number	FLUENCY Obs.	FLEXIBILITY Obs.	FLEXIBILITY Pred.	ORIGINALITY Obs.	ORIGINALITY Pred.	ELABORATION Obs.	ELABORATION Pred.
1	3	3	3.8	1	4.9	1	8.0
2	4	4	4.5	9	5.9	6	8.7
3	5	4	5.2	7	6.9	9	9.3
4	5	5	5.2	6	6.9	8	9.3
5	6	6	5.9	10	8.0	9	10.0
6	6	6	5.9	7	8.0	9	10.0
7	6	6	5.9	9	8.0	2	10.0
8	6	6	5.9	7	8.0	6	10.0
9	6	6	5.9	10	8.0	7	10.0
10	7	7	6.6	12	9.0	15	10.6
11	7	6	6.6	6	9.0	5	10.6
12	7	7	6.6	7	9.0	21	10.6
13	8	6	7.3	10	10.1	9	11.3
14	8	8	7.3	18	10.1	15	11.3
15	8	7	7.3	5	10.1	22	11.3
16	9	7	8.0	14	11.1	15	11.9
17	9	6	8.0	9	11.1	8	11.9
18	9	9	8.0	14	11.1	15	11.9
19	9	9	8.0	8	11.1	4	11.9
20	10	9	8.7	7	12.1	7	12.5
21	10	7	8.7	9	12.1	18	12.5
22	11	10	9.4	16	13.2	31	13.2
23	11	11	9.4	10	13.2	14	13.2
24	12	11	10.1	12	14.2	12	13.8
25	12	12	10.1	14	14.2	3	13.8
26	13	13	10.8	21	15.3	21	14.5
27	13	13	10.8	14	15.3	9	14.5
28	18	10	14.4	29	20.5	40	17.6
29	26	20	20.0	24	28.8	6	22.8

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